§8. Development of Proportional Counter to Measure the Tritium in the Air

Ogata, Y. (Nagoya University School of Health Sciences)
Sakuma, Y.

Tritium will be generated at the DD plasma experiment, which will be one of the next projects of National Institute of Fusion Sciences. To guaranty safety of the experiments, tritium concentration in the work place and in the environment should be promptly monitored. There are three chemical forms; i.e. H_2O, H_2, and CH_4, of tritium in the atmospheric air. The tritium concentration is conventionally estimated with liquid scintillation counting by measuring the trapped water vapor and trapped vapor of water oxidized hydrogen and methane gases. The method, however, requires lots of time and labor to collect the vapor, to exchange the chemical forms of hydrogen and methane gases, and to count the samples. The purpose of this study is to develop a proportional counter for real-time monitoring of tritium in hydrogen and methane discriminated from the other kinds of gases.

The flow type of proportional counter, 37-cm long, 29 mm in inner diameter was made of brass. The anode was made by a tungsten wire of 50 or 20 μmϕ. Although a hermetic seal is generally used to support the anode at the end of the counter, in this study an acrylic plate is used for simplifying the construction of the counter. The anode wire was fixed by the acrylic disks with an epoxy resin. The gas amplification effect of the anode diameter was also investigated. PR gas, Ar, and hydrogen were used for counting gases at room temperature. The plateau characteristics were measured using an external ^{137}Cs source. The gas amplification factor, M, was calculated using the equation derived by Diethorn[1] as follows;

$$\ln M = \frac{V}{\ln(b/a)} \cdot \frac{\ln 2}{\Delta V}\left[\ln \frac{V}{pa\ln(b/a)} - \ln K\right] \qquad (1)$$

where a is the anode radius, b is the cathode radius, V is the applied voltage, p is the gas pressure, and ΔV and K are the constants according to the fill gas, respectively.

Figure 1 shows the plateau curves. The narrower the anode radius, the lower the plateau by increasing in the electric field strength in the vicinity of the anode. Figure 2 shows the gas amplification factor of PR gas calculated by Eq. 1. Narrower anode has higher amplification factor. The higher amplification factor made the true signal higher, hence the nose-reduction easier. The high amplification factor has advantages to detect low energy beta rays such as beta rays emitted from tritium. When hydrogen gas was used for counting gas, however, an electric discharge occurred at 1800 V, which was lower than the start of the plateau. The surface discharge of the epoxy resin or acrylic plate would provably happen. The hermetic seal, with which such a discharge did not occur at those potentials, was available for anode supporting for our previous study[2]. However, the hermetic seal made the counter construction complex, so that the anticoincidence system for background reduction, which is our next subject, could not be installed. Therefore, there are problem to examine the anode supporter with high electric field strength and with simple construction.

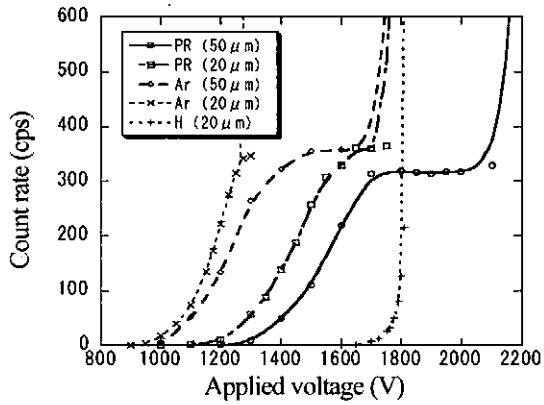

Fig. 1 The plateau potential.

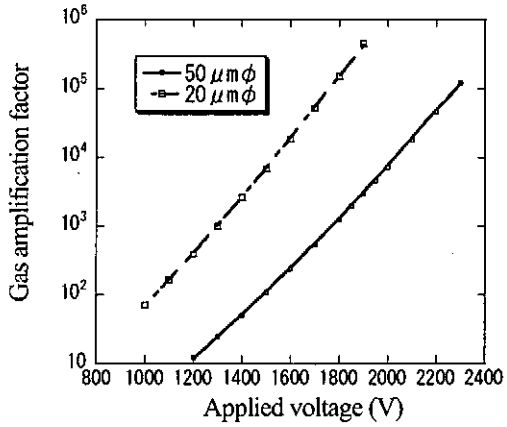

Fig. 2 The amplitude rate.

References
1) W. Diethorn, NYO-6628 (1956)
2) Ogata, Y. et al.: Proc. 3ed Workshop Environ. Radioactivity. KEK (2002) 109